NOTES ON PEA APHID CONTROL MEASURES FOR THE PAST SIX YEARS

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During the early years of the pea aphid project the principal control measures employed consisted of spraying and dusting mostly with nicotine preparations, and of collecting the aphids from the plants by mechanical means.

Experiments with nicotine dust continued until 1938, but in 1933 additional methods of treating aphids began to be tested when the first experiments were made with atomized oil.

Experiments with Atomized Oils with and without Added Insecticides as a Control of the Pea Aphid

It was felt that if atomized oils, alone or in combination with other insecticides, could be shown to be effective against the pea aphid, only a few gallons of oil would be required to treat an acre of peas, and the great weight of the water necessary to apply per acre would be eliminated.

In 1933 the oil used was regular kerosene (Perfection oil). In some tests kerosene alone was applied, and in other tests a commercial pyrethrum extract containing 2.15 grams of pyrethrins per 100 c.c. of solution was added in sufficient quantity to make a 5-1/3 percent solution.

The results of these tests were disappointing. The highest mortality obtained was 70 percent, and in most tests it was much lower. The mortality was much higher, however, when pyrethrum was added to the kerosene than when the oil was used alone.

In one series of tests no foliage injury was observed. In another series there was severe foliage injury. In addition, the kerosene penetrated the newly formed pods, and at harvest time the odor of the oil still could be detected on the shelled peas.

In 1934 Deo-base oil, a highly refined kerosene product, was used in place of regular kerosene oil. Pyrethrum extract, derris extract, and nicotine oleate were used in combination with this oil.

As there appeared to be no equipment on the market suitable for the application of atomized oil to field plots, it was necessary to purchase the different parts and then to design and construct the completed machine, even to the atomizing nozzles. The 10 foot boom was adjustable to cover a swath from 6 to 10 feet wide and was equipped with 12 specially designed atomizing nozzles. Each nozzle was connected to both air and oil tanks by separate pipes.

A positive feed control was obtained by maintaining air pressure over the oil in the insecticide tank. By means of a pressure regulating valve, it was very easy to increase or decrease the rate of oil discharge merely by varying the air pressure in the oil tank. The pressure on the air line was maintained at from 20 to 30 pounds per square inch.

This equipment was mounted on a light two-wheeled trailer. By means of an angle iron framework covered with an oil-resisting cloth product, the trailer was made into an enclosed hood 14 feet long by 10 feet wide for the purpose of confining the oil mist among the plants for a few seconds. The truck pulling the trailer traveled at an average rate of 2 miles per hour.

Deo-base oil, combined with other toxic materials, was used in all the tests. The rates of application were 6, 8, and 12 gallons of material per acre. In most tests 2½ percent of a concentrated pyrethrum extract containing 2.15 grams of pyrethrins in 100 c.c. of solution was used with the oil. No foliage injury was observed with this combination even when the application was at the rate of 12 gallons per acre.

In all of these tests the aphid mortality was low, reaching 60 percent or 65 percent as a maximum.

Practically all aphids exposed to the direct mist were readily killed, while most of those protected in the blossom clusters and on the side of the plants not hit by the mist were not killed. The blossom clusters, pointing in all directions, proved to be excellent protection to the aphids against the mist. It was possible to obtain good coverage on one side of the plants only, for the mist did not fill the hood as had been anticipated but disappeared in a second or two after leaving the nozzles. This dissolution of the mist was very rapid, and at no time was there any concentration of mist built up under the tight hood. Most of the mist contacted the plants immediately after leaving the nozzles, although part of it volatilized into the very dry air.

No experiments have been conducted at this laboratory using an airplane or an Autogiro for applying oils against the pea aphid.

Experiments with Steam as a Carrier for Insecticides in Pea Aphid Control

In 1935 tests were commenced with another method of treating aphids. Steam vapor was employed as a medium for dispersing insecticides in a further attempt to reduce the gallonage of water which is required per acre when ordinary sprays are used and in an effort to secure even better coverage of the foliage than has been possible with water sprays.

The project was conducted in cooperation with the Bureau of Agricultural Engineering, U. S. Department of Agriculture, during the seasons 1935, 1936, and 1937.

A machine called a "Hy-Pressure Jenny" and manufactured commercially for cleaning greasy machinery, railroad cars, and automobiles was employed in these experiments. Water is heated under pressure by an oil burner, but steam is not formed until the superheated water is released at the nozzles. This enables other liquids, dissolved solids, and solids in suspension to be carried to the nozzles.

This machine was modified for the application of insecticides. A separate insecticide tank was installed and equipment was devised for injecting the insecticide into the hot water pipe just before it reached the nozzles so that the insecticide would not be subjected to high temperature for any length of time.

The apparatus operated at a steam pressure of approximately 80 pounds per square inch at the outlet of the coils where the insecticide was injected. Thus the temperature at the mixing point was approximately 310° F.

The boom, 10 feet long, was equipped with 12 nozzles which could be set at various angles. It was entirely enclosed with canvas, and a 25 foot trailer was attached. In no instance was foliage injury observed except where the apparatus was operated at a standstill for 10 seconds or more. The steam cooled very rapidly after leaving the nozzles, and it was possible to pass the hand through the vapor at a distance of 12 inches from the nozzles without discomfort.

The apparatus was mounted on a pick-up truck and driven directly over the peas like a conventional sprayer or duster at an average speed of two miles per hour.

It was originally hoped to secure coverage of the plants and control of the aphid with the use of a very low gallonage of water per acre. However, the rate of application in most all of the tests the latter two years ranged from 50 to 60 gallons per acre in 1936 up to nearly 100 gallons per acre in 1937.

The insecticides used included the following: Nicotine sulphate, free nicotine (50% nicotine), derris extract, pyrethrum extract, and ground derris root in water. These materials were used in various concentrations with and without spreading and wetting agents. Several emulsions containing ground derris root were prepared and tested, as well as combinations of derris and nicotine, derris and an aliphatic thiocyanate, and derris and phenothiazine.

The mortality in some of the preliminary trials conducted in 1935 was very low, ranging from 5 percent to 40 percent, but satisfactory mortalities were obtained in most of the tests conducted during 1936 and 1937. Even some of the materials applied at the rate of 50 gallons per acre resulted in satisfactory control, ranging from 85 percent to 98 percent.

The best and most consistent control was obtained with ground derris root, either alone or in combination with other toxic materials.

The big drawback to this method of control was the limitation of the equipment. It appears that the equipment now available is too costly, too heavy, and too complicated for practical field use. Moreover, the acreage treated per hour is much too small, and at the rate of from 50 to 100 gallons of water per acre, the saving in gallonage is not as great as was originally anticipated.

Derris and Cube as Dusts and Sprays and Nicotine Vapor

Commencing in 1935 derris and cube in the form of dust mixtures and sprays were tested in the pea aphid control program.

With the advent of rotenone-bearing materials and their early promise of giving satisfactory control of the aphid, efforts were made to improve dusting and spraying equipment. Inasmuch as the derris and cube did not effect immediate control, it became imperative to distribute both dust and spray as thoroughly as possible among the foliage and to have the materials adhere to the foliage as long as possible. Thus, equipment was sought which had sufficient power to deliver the dust with force and in a very finely divided state, on the one hand, and to thoroughly atomize the spray and deliver it under high pressure, on the other hand.

Canners soon expressed the desire for equipment capable of treating a large acreage a day, and the problem of developing machinery of increased capacity and power is rapidly being met by manufacturers.

Research was necessary not only in regard to equipment, but especially for the purpose of developing effective dust and spray mixtures. It was soon discovered that both derris and cube dusts and sprays were more effective against the aphid when containing a spreading and wetting agent than when they were used with a dispersing agent only. This led to three years of research to determine the best type of spreading and wetting agents, the proper quantity to use, and the best method of incorporating them into the final mixtures. This work is still going on.

The general recommendations for handling the equipment in the application of dusts and sprays are familiar enough to you so that a repetition of them is not necessary here.

In 1937 experiments were commenced with nicotine vapor in which the aphids were subjected to fumigation by heated nicotine vapor released in a wind-tight chamber and under a long trailer. This method of aphid control also is familiar to you.

Summary of Results of Pea Aphid Control in 1938.

The experimental plots of 1938 comprised a total of 23 acres of gently rolling land, 21 of which were devoted to 42 half-acre plots.

The peas were planted late in April. Favorable weather and soil conditions assisted in producing fine germination of the seed and an excellent stand of peas. Generally cool, moist weather continued throughout the pea-growing season, resulting in large succulent plants which appeared able to withstand considerable aphid infestation without sustaining severe injury.

By the middle of June it appeared that with the favorable weather conditions being experienced and the heavy plant growth, little damage would be caused by the infestation then present. The infestation increased until by June 22 it was moderate but could not be called heavy in any of the plots. Heavy rainstorms commencing on June 23 and continuing intermittently until harvest reduced the infestation definitely and kept it down until harvest.

The treatments comprised five derris dust combinations, two derris sprays, and nicotine vapor, each of which was replicated on four half-acre plots, and two derris dust combinations applied under different conditions to one or two plots in each test. These treatments together with four check plots made up the 42 half acres.

The average quantity of the different materials applied per acre was as follows: dust, 34½ pounds; spray, 100 gallons; and nicotine, 3 pounds. The average rate of travel was 2¼ miles per hour.

Most of the treatments were applied when the infestation averaged close to 75 aphids per sweep of a net.

The degree of control of the aphid did not increase as rapidly after treatment, nor did it reach as high a point as has been the case the past two years. However, it did increase slowly, reaching its maximum height ten days after treatment, as compared to eight days after treatment in 1937 and four days after treatment in 1936.

The average yield of all the treated plots was 3038 pounds of shelled peas per acre, while the average yield of the four checks was 2570 pounds per acre. Thus, the average increase in yield of all treatments over checks was 466 pounds per acre of a gross value of $13.63 per acre. The gross value of the average increase in yield was well above the average cost of treatment, estimated by canners to be somewhere between $3 and $5 per acre.

The maximum reduction in the infestation, the yield, and the increase in yield shown as averages of four replicates are presented for seven of the treatments.

TABLE I.

REDUCTION IN THE INFESTATION AND YIELD OF PEAS
Waunakee, Wisconsin, May-July, 1938.

Treatment	Maximum reduction in the infestation Percent	Yield in pounds of shelled peas per acre	
		Ave. of 4 replicates	Increase over the 4 checks
Conditioned derris dust, 0.75% rotenone Early treatment	84	3163	593
Same dust Regular treatment	89.5	3066	496
Same dust Late treatment	92.6	3080	510
Conditioned derris dust, 1.0% rotenone	91.3	3073	503
Unconditioned derris dust, 0.75% rotenone	90.7	2958	338
Conditioned derris spray, 0.005% rotenone	85.5	2787	217
Conditioned derris spray, 0.015% rotenone	92.6	3112	542

There is very little difference in the reduction in the infestation resulting from the seven treatments. With the possible exception of the treatment involving derris spray at the concentration of 0.005 percent rotenone, the difference in the yields is slight.

Through no fault of ours, the nicotine vapor was applied much too late, and even though the treatment resulted in a small increase in yield, the results of this treatment are not comparable to the other results.

Probably the most significant fact in 1938 was that every treatment resulted in an increase in yield. Of a total of 13 treatments, only four did not result in increases in yield large enough to pay the average cost of treatment.

A comparison of the reduction in the infestation and the yields of all treatments for the past three seasons follows:

TABLE II.

REDUCTION IN THE INFESTATION AND YIELD OF PEAS AT THE EXPERIMENTAL PLOTS FOR THE PAST THREE YEARS
Waunakee, Wisconsin, 1936-1938.

Year	Maximum reduction in the infestation Percent	Pounds of shelled peas per acre		Percent increase
		Ave. of all treated large plots	Ave. of all checks	
1936	98	1621	1053	54
1937	96.5	1703	1335	27.5
1938	90.5	3038	2570	18

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